

# **Engineering Evaluation/Cost Analysis for the 105-KE and 105-KW Reactor Facilities and Ancillary Facilities**

May 2006



**United States Department of Energy**

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P.O. Box 550, Richland, Washington 99352



## EXECUTIVE SUMMARY

This document presents the results of an evaluation of three removal action alternatives for the disposition of approximately 85 facilities (buildings or structures) in the 100-K Area of the Hanford Site plus the 105-K East (KE) and 105-K West (KW) Reactor Buildings. The U.S. Department of Energy, Richland Operations Office has determined that the facilities have no further use beyond their current mission. The potential threat of release of hazardous substances in the facilities poses a substantial risk to human health and the environment and therefore justifies use of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) (42 U.S.C. 9601) removal action authority in accordance with Section 300.415 (b)(2) of the *National Oil and Hazardous Substances Pollution Contingency Plan* (40 *Code of Federal Regulations* 300). An action memorandum, which will be developed from this engineering evaluation/cost analysis (EE/CA), will document and authorize implementation of the removal action that is selected for the facilities.

This is the second EE/CA prepared for disposition of facilities in the 100-K Area. The *Engineering Evaluation/Cost Analysis for the 100-K Area Ancillary Facilities* (DOE-RL 2004) addressed 27 support buildings in the 100-K Area. That EE/CA recommended immediate deactivation, decontamination, decommissioning, and demolition (D4) of each building as the preferred alternative for disposition of the facilities.

This document addresses the remaining 100-K Area facilities, site conditions, and the source and extent of contamination to provide a framework for the discussion of removal action objectives and alternatives. Finally, each removal action alternative is compared against the criteria of effectiveness, implementability, and cost.

Removal actions evaluated for the 105-KE and 105-KW Reactors and ancillary facilities include (1) no action; (2) interim safe storage (ISS) of the 105-KE and 105-KW Reactors followed by long-term surveillance and maintenance (S&M), and D4 of ancillary facilities and portions of the 105-KE and 105-KW Reactor Facilities; and (3) long-term S&M followed by D4 of ancillary

facilities and the 105-KE and 105-KW Reactor Facilities. The alternatives are summarized below.

- The no action alternative assumes all short-term and long-term maintenance of the facilities is terminated and the facilities are locked to prevent entry.
- ISS, which has been performed or is in progress at other Hanford Site reactor facilities, includes D4 of the reactor building up to the shield walls that surround the reactor block, the construction of a safe storage enclosure (SSE), and S&M. This alternative also provides D4 of the ancillary facilities and portions of the 105-KE and 105-KW Reactor Facilities, which consist of immediate deactivation and any required decontamination of the facilities followed by demolition and associated waste disposal of the contaminated debris.
- The long-term S&M Alternative includes an extended period of facility monitoring with major and minor repairs as necessary, followed by eventual D4 of the facilities in preparation of final disposition of the 105-KE and 105-KW Reactor blocks.

Present-worth cost estimates for the three alternatives are shown in Table ES-1. Consistent with guidance established by the U.S. Environmental Protection Agency and the U.S. Office of Management and Budget, present-worth analysis is used as the basis for comparing costs of cleanup alternatives under CERCLA.

The recommended removal action alternative for the 105-KE and 105-KW Reactors and 100-K Ancillary Facilities is Alternative II; ISS of the reactors followed by long-term S&M and D4 of the ancillary facilities and portions of the 105-KE and 105-KW Reactor Facilities. This alternative is consistent with the previous evaluations for the 105-C, 105-D, 105-DR, 105-F, and 105-H Reactors as well as the previous evaluation for other facilities at 100-K. This alternative is recommended based on its overall ability to protect human health and the environment and its effectiveness in maintaining protection for both the short and long term. The alternative would also reduce the potential for a release to the environment by reducing the inventory of contaminants. This alternative provides the best balance of protecting human health and the

environment, protecting workers, and providing an end state that is consistent with future cleanup actions and commitments of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989).

**Table ES-1. Cost Comparison for Removal Action Alternatives for the 105-KE and 105-KW Reactors and Ancillary Facilities.**

Alternative	Nondiscounted Estimated Cost	Discounted Estimated Cost
Alternative I – No Action	No cost	No cost
Alternative II - ISS of the 105-KE and 105-KW Reactors followed by long-term S&M, and D4 of ancillary facilities and portions of the 105-KE and 105-KW Reactor Facilities	\$ 80,502,612	\$ 71,812,282
Alternative III - Long-term S&M with eventual D4 of ancillary facilities and the 105-KE and 105-KW Reactor Facilities	\$ 84,683,047	\$ 44,518,638

D4 = deactivation, decommissioning, decontamination, and decommissioning

KE = K East

KW = K West

S&M = surveillance and maintenance

Alternative I was not recommended because the facilities would not be decontaminated and no action would be taken to stop the facilities from deteriorating, and there would be an increased threat and likelihood for a release of hazardous substances, potentially exposing workers, the public, or the environment. Similarly, Alternative III was not recommended because, while reaching essentially the same end point as Alternative II, the contamination and structures are left in place for much longer, and therefore the potential environmental and personnel risks are extended and, in fact, increased as the buildings age.



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## ACRONYMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CFR	<i>Code of Federal Regulations</i>
D4	deactivation, decontamination, decommissioning, and demolition
DOE	U.S. Department of Energy
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FR	<i>Federal Register</i>
HEPA	high-efficiency particulate air
IPB	Integrated Project Baseline
ISS	interim safe storage
KE	K East
KW	K West
NEPA	<i>National Environmental Policy Act of 1969</i>
NHPA	<i>National Historic Preservation Act of 1966</i>
OU	operable unit
PCB	polychlorinated biphenyl
RAWP	removal action work plan
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RL	Richland Operations Office
ROD	Record of Decision
S&M	surveillance and maintenance
SSE	safe storage enclosure
TBC	to be considered
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
TSCA	<i>Toxic Substance Control Act of 1976</i>
TSD	treatment, storage, and disposal
WAC	<i>Washington Administrative Code</i>

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96.0	96.0
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100.0	100.0

## METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>	<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>
<b>Length</b>			<b>Length</b>		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
<b>Area</b>			<b>Area</b>		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
<b>Mass (weight)</b>			<b>Mass (weight)</b>		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
<b>Volume</b>			<b>Volume</b>		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
<b>Temperature</b>			<b>Temperature</b>		
fahrenheit	subtract 32, then multiply by 5/9	celsius	celsius	multiply by 9/5, then add 32	fahrenheit
<b>Radioactivity</b>			<b>Radioactivity</b>		
picocuries	37	millibecquerel	millibecquerels	0.027	picocuries



## 1.0 INTRODUCTION

### 1.1 PURPOSE AND SCOPE

This document presents the results of an engineering evaluation/cost analysis (EE/CA) that was conducted to evaluate alternatives and recommend an approach for disposition of the 105-KE and 105-KW Reactor Facilities and below-grade structures and remaining ancillary facilities (subsequently referred to as facilities<sup>1</sup>). Excluded from this analysis were the fuel storage basins and final disposition of the reactor blocks. The reactor blocks will remain in a safe storage mode, consistent with the current anticipated time frame for decommissioning of the eight other surplus Hanford Site reactors, which is expected to be complete by 2068. The disposition of the fuel storage basins will be completed in accordance with the *K-Basins Interim Action Record of Decision* (ROD) (EPA 1999b) and any subsequent amendments and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (commonly referred to as the Remaining Sites ROD) (EPA 1999a).

All of the remaining ancillary facilities at the 100-K Area not currently addressed under another *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) action are also addressed in this EE/CA. These facilities are currently inactive or will be deactivated when the K Basin Closure Project is complete, and the U.S. Department of Energy (DOE), Richland Operations Office (RL) has determined there is no further use for them. Hazardous substances<sup>2</sup> in these facilities present a potential threat to human health and the environment to the extent that action is warranted for the facilities. The lead regulatory agency, the U.S. Environmental Protection Agency (EPA), has determined that a non-time-critical removal action is appropriate to mitigate the potential hazards present in the 100-K Area buildings. An action memorandum, which will be developed from this EE/CA, will document and authorize implementation of the removal action that is selected for the facilities.

This EE/CA was prepared to develop removal action alternatives for the remaining 100-K Area ancillary facilities noted in Appendix A. The scope of the subsequent removal action will address the facilities and, in some cases, newly discovered soil contamination.

The soil adjacent to or underlying some of the facilities may be contaminated. Where there is previous knowledge of such contamination, the soil has already been identified as a separate waste site and will be remediated under the authority of CERCLA remedial actions under the 100-KR-1 and 100-KR-2 OU RODs. If extensive contamination associated with the adjacent or underlying soil is identified in the future, it will be identified as a new waste site and addressed

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<sup>1</sup> The term "facility" is used generically to encompass all the structures, facilities, piping, ducting, etc., associated with the building.

<sup>2</sup> "Hazardous substances" means those substances defined by the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, Section 101(14), and includes both radioactive and chemical substances.

under the 100-KR-1/100-KR-2 OU remediation process or other soil remediation activity (i.e., the Remaining Sites ROD [EPA 1999a]).

Any other facilities and foundations within the geographical boundary (i.e., man-made items built or placed in the area) of the removal action (see Figure 1-2) that are discovered and are not addressed by the 100-KR-1 and 100 KR-2 OU RODs, the previous ancillary facilities removal action (DOE-RL 2004), or other soil remediation activity (i.e., the Remaining Sites ROD [EPA 1999a]) may be included in the removal action as provided in the action memorandum provided they are sufficiently similar to the sites addressed by this EE/CA such that additional analysis of removal alternatives would not be necessary or appropriate.

Subsurface structures and remediation of soils already identified as waste sites and covered under existing 100-KR-1 and 100-KR-2 OU RODs are excluded from this evaluation. However, where the existing waste site is to be fully removed in the building footprint or layback, the remediation of these waste sites may be completed in conjunction with this removal action and verified to meet the cleanup requirements of the applicable ROD. Unanticipated contaminated soil found during and/or remaining after structure removal may be identified as a new waste site. Relatively small contamination areas may be remediated/removed along with removal of structures as provided in the action memorandum. In the event that large volumes of contaminated soil are encountered, other soil contamination sites are adversely affected by D4 activities, utilities of active facilities are impacted, or removal of contaminated soil inhibits D4 activities, the action memorandum may provide that removal of contaminated soils or structure (i.e., slab, below-grade structure) may be deferred to future remedial action with approval of the EPA. The sites will be stabilized in a manner that will not hinder future remediation, and will be cleaned up in accordance with the Remaining Sites ROD (EPA 1999).

## 1.2 BACKGROUND

The Hanford Site is a 1,517-km<sup>2</sup> (586-mi<sup>2</sup>) federal facility located in southeastern Washington State, along the Columbia River (Figure 1-1), and operated by the DOE. From 1943 to 1990, the primary mission of the Hanford Site was the production of nuclear materials for national defense. The 100 Area is the site of nine now-retired nuclear reactors and associated support facilities that were constructed and operated to produce weapons-grade plutonium. Past operations, disposal practices, spills, and unplanned releases resulted in contamination of the facility structures, underlying soil, and underlying groundwater in the 100 Area. Consequently, in November 1989, the 100 Area was one of four areas of the Hanford Site that was placed on the EPA's National Priorities List under CERCLA, as amended by the *Superfund Amendments and Reauthorization Act of 1986* (42 U.S.C. 9601 et seq.).

The 100-K Area is the portion of the 100 Area that contains the 105-KE and 105-KW Reactor Buildings and supporting facilities (Figure 1-2). The area is subdivided into three OUs to address cleanup of the soil and groundwater contamination that resulted from past operations. The 100-KR-1 and 100-KR-2 OUs encompass liquid waste disposal sites, burial grounds, and soil waste sites. The 100-KR-4 OU addresses groundwater contamination underlying the



100-K Area. Geographically, the buildings addressed in this EE/CA are co-located with the 100-KR-1 and 100-KR-2 OU waste sites. The scope and role of other CERCLA cleanup actions in the 100-K Area, and their relationship to this removal action, are summarized in the following subsections.

### 1.2.1 Waste Site and Soil Cleanup

Approximately 50 waste sites with a range of radioactive and nonradioactive contaminants have been identified in the 100-K Area as part of the 100-KR-1 and 100-KR-2 OUs. Remediation of these sites is being conducted under the following three CERCLA interim action RODs:

- The *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units* (EPA 1997) addresses liquid effluent disposal sites, including those in the 100-K Area.
- The *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (commonly referred to as the Remaining Sites ROD) (EPA 1999a) addresses remediation of additional liquid and miscellaneous waste disposal sites.
- The *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units Hanford Site (100 Area Burial Grounds), Hanford Site, Benton County, Washington* (commonly referred to as the 100 Area Burial Grounds ROD) (EPA 2000) addresses remediation of burial grounds.

Based on a rural-residential land-use scenario, the selected remedial action specified in these RODs includes removal of contaminated soil and debris, treatment (as necessary to meet disposal facility acceptance criteria), and disposal. This remedial action is commonly referred to as remove, treat, and dispose.

Remediation of waste sites in the 100-K Area is underway. The proximity of some waste sites to facilities in the scope of this EE/CA may require specific scheduling and coordination between the waste site and facility remediation programs.

In addition to addressing known waste sites, the Remaining Sites ROD (EPA 1999a) provides guidelines by which newly discovered sites may be designated as remove, treat, and dispose sites or categorized as candidates for no further action (candidate sites) pending evaluation. These guidelines will be pertinent to residual contamination (e.g., subsurface structures or soil) at the facilities addressed in this EE/CA.

### 1.2.2 Groundwater Cleanup

Chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU). Remediation of the chromium is being conducted under the interim action *Interim Action Record*

of Decision for the 100-HR-3 and 100-KR-4 Operable Units at the Hanford Site, Benton County, Washington (EPA 1996). As required by the 100-HR-3 and 100-KR-4 ROD, a full-scale pump-and-treat system was constructed in the 100-K Area with the objective of removing hexavalent chromium via ion-exchange technology. The treated groundwater is reinjected upgradient in the 100-K Area. The system has been operating since 1997. No specific impacts on 100-K Area facilities' remediation are anticipated, other than nominal coordination of field activities. The demolition of the pump-and-treat system will be performed as part of this removal action, unless the decision is made to continue operating the system beyond the completion date of the removal action.

### 1.2.3 100-K Area Fuel Storage Basins Cleanout

The 105-KE and 105-KW fuel storage basins (K Basins), located respectively adjacent to the 105-KE and 105-KW Reactor Facilities, had been the storage locations for the spent nuclear fuel since the 1970s. The basins contain contaminated sludge, water, debris, and some spent fuel and fuel fragments that are being found in the sludge. The basins are included in the 100-KR-2 OU. The K Basins themselves are not within the scope of this EE/CA. As stated above, the disposition of the fuel storage basins will be completed in accordance with the K Basins Interim Action ROD (EPA 1999b) and any subsequent revisions.

## 1.3 REMOVAL ACTION AUTHORITY

The *Policy on Decommissioning Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* (DOE and EPA 1995) is a joint policy between DOE and EPA that allows use of the CERCLA Removal Action<sup>3</sup> process (40 *Code of Federal Regulations* [CFR] 300.415) for deactivation, decontamination, decommissioning, and demolition (D4) activities. The facilities must contain hazardous substances to qualify for inclusion in the removal action process. The removal action process also requires preparation of an EE/CA to identify and evaluate alternatives for proposed removal actions.

This EE/CA was prepared in accordance with CERCLA and 40 CFR 300.415 to satisfy environmental review requirements for non-time-critical removal actions and to provide a framework to evaluate and select from among alternative approaches for disposition of the identified 100-K Area remaining facilities. This EE/CA also specifies actions designed to comply with requirements of the DOE and EPA joint policy (DOE and EPA 1995) and the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). The EPA, Washington State Department of Ecology, and DOE (referred

<sup>3</sup> "Remove" or "removal," as defined by Section 101(23) of CERCLA, refers to the cleanup or removal of released hazardous substances from the environment; actions if a threat of hazardous substances release occurs; actions to monitor, assess, and evaluate the release (or threat of release) of hazardous substances; the disposal of removed material; or other actions that may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release. If a planning period of at least six months exists before onsite actions must be initiated, the removal action is considered non-time-critical, and an EE/CA is conducted.

to as the Tri-Parties) have determined that the remaining facilities included in the scope of this EE/CA qualify for the removal action process, based on the known presence of hazardous substances. After the public has had an opportunity to comment on the alternatives and the recommended approach presented in this document, the Tri-Parties will select the most appropriate removal action for the facilities. The DOE will prepare an action memorandum (a CERCLA decision document), subject to EPA approval, to reflect the decisions made by the Tri-Parties.

Consistent with the *National Environmental Policy Act of 1969* (NEPA) (42 U.S.C. 4321 et seq.), an Environmental Impact Statement (EIS) has been prepared on the disposition of the Hanford Site reactors (excluding the 100-N Reactor), which is documented in *Final Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington* (DOE 1992). The purpose of the EIS was to provide environmental information to assist DOE in selecting a decommissioning alternative for the eight surplus reactors at the Hanford Site. The EIS ROD (58 *Federal Register* [FR] 48509) documented the DOE's selection of safe storage of the reactors followed by deferred one-piece removal of the reactor blocks and disposal at the Hanford Site 200 West Area as the preferred decommissioning alternative. This EE/CA supports the EIS and ROD and provides a detailed evaluation of the safe storage alternatives for the 105-KE and 105-KW Reactors.

In accordance with the *Secretarial Policy on the National Environmental Policy Act* (DOE 1994) and NEPA, the NEPA values have been incorporated into this EE/CA. The policy statement and DOE order encourage integration of NEPA values into CERCLA documents (such as this EE/CA) to the extent practicable, rather than requiring separate documentation. A discussion of NEPA values is included in Section 5.4 of this document.

One of the facilities, the 1706-KE Building, has a small area that is called the "1706-KE Waste Treatment System," which is regulated as a treatment, storage, and disposal (TSD) unit under the *Resource Conservation and Recovery Act of 1976* (RCRA) (42 U.S.C. 6901 et seq.). This TSD unit is composed of several major components including an accumulation tank, an ion-exchange column, an evaporator unit, a condensate collection tank, and a high-efficiency particulate air (HEPA) filtration unit. The Tri-Parties have agreed to integrate the cleanup and closure of this TSD unit with the CERCLA process. The TSD portion of the 1706-KE Building will be remediated under the authority of the Remaining Sites ROD (EPA 1999a) as provided by the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision* (EPA 2004). The disposition of the rest of the 1706-KE Building is within the scope of this EE/CA.

This EE/CA describes the 100-K Area and discusses the specific reactor portions and ancillary facilities to be dispositioned. Additionally, site conditions and the sources and extent of contamination are presented to provide a framework for the discussion of removal action objectives and alternatives. Finally, each alternative is compared against a set of CERCLA criteria in order to identify a preferred removal action alternative.

## 1.4 SCHEDULE DRIVERS

In 1989, the Tri-Party Agreement established a procedural framework and schedule for cleanup actions at the Hanford Site. The Tri-Party Agreement Milestones for the KE and KW Buildings and Tri-Party Agreement milestones impacting interim safe storage (ISS) and facility D4 work are identified in Tables 1-1 and 1-2.

**Table 1-1. Tri-Party Agreement Milestones for the KE and KW Buildings.**

Milestone	Description	Due Date
M-016-00	Complete remedial action for all non-tank farm operable units	9/30/2024
M-16-00A and M-016-53	Complete interim response actions for the 100-K Areas	12/31/2012
M-93-00	Complete final disposition of 100 Area surplus production reactor buildings	To be decided
M-093-22	Complete ISS of 105-KE	9/30/2011
M-093-22	Complete ISS of 105-KW	9/30/2011
M-093-23	Submit EE/CA for KE/KW Reactor ISS	7/31/2006

EE/CA= engineering evaluation/cost analysis

ISS = interim safe storage M-093-23

KE = K East

KW = K West

**Table 1-2. Tri-Party Agreement Milestone Impacting KE and KW Interim Safe Storage and Building D4 Work.**

Milestone	Description	Due Date
M-016-57	Begin "full scale" soil remediation under 105-KE Fuel Storage Basin	4/30/2007
M-034-00A	Complete removal KE and KW Fuel Storage Basins and contents	3/31/2009
M-016-58	Begin "full scale" soil remediation under 105-KW Fuel Storage Basin	4/30/2009

D4 = deactivation, decontamination, decommissioning, and demolition

ISS = interim safe storage

KE = K East

KW = K West